CSS — Ultimate Monster Scroll (Chapters 1 → 14)

Chapter 1 — Foundations & Syntax (Deep)

What CSS is
CSS = Cascading Style Sheets. It's the presentation layer. HTML = structure/content; CSS = visuals & layout.

How browsers apply CSS (high-level)

1. Browser loads HTML → builds DOM.
2. Browser loads CSS → builds CSSOM.
3. DOM + CSSOM → Render Tree → layout → paint.
   Understanding render pipeline helps performance decisions (avoid expensive paints/layouts).

Rule anatomy

css
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`selector { property: value; property2: value2; }`

Selectors choose nodes; declarations set computed styles.

How to include

- External: `<link rel="stylesheet" href="styles.css">` — best practice.
- Internal: `<style>` in `<head>` — fine for small pages.
- Inline: `style="..."` — overrides and hard to maintain.

Order of precedence (cascade)

1. Browser default (user agent).

2. User styles (rare).

3. Author styles (your CSS).
   Within author: later rules override earlier if same specificity. `!important` overrides normal cascade (use sparingly).

Box-sizing reset (must)
Use this on every project:

css
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```
*, *::before, *::after { box-sizing: border-box; }
```

Reason: With `border-box`, width includes padding & border — less brain math.

Exercise 1

- Create `index.html` and `styles.css`. Add `<h1>Hello</h1>` and style the `h1` via external CSS. Toggle inline style to see specificity.

Chapter 2 — Selectors & Specificity (Deep)

Selectors list (priority & features)

- Type: `div`, `p`
- Class: `.btn`
- ID: `#main`
- Attribute: `a[target="_blank"]`, `input[type^="text"]`
- Pseudo-class: `:hover`, `:focus`, `:nth-child(3n)`

- Pseudo-element: `::before`, `::after`, `::first-letter`

Combinators

- Descendant: `A B` — any depth.
- Child: `A > B` — direct child only.
- Adjacent sibling: `A + B` — immediately after.
- General sibling: `A ~ B` — any following sibling.

Specificity scoring (how browsers pick rules)

- Inline styles: score `(1,0,0,0)` — highest.
- IDs: `(0,1,0,0)` each ID adds.
- Classes/attrs/pseudo-classes: `(0,0,1,0)`.
- Elements/pseudo-elements: `(0,0,0,1)`.
  Compare lexicographically. Later rules break ties.

Common pitfalls

- Overly specific selectors (e.g., `body .nav ul li a {}`) → hard to override.
- Using `!important` to fix issues — leads to maintenance hell.

`:not()` and advanced pseudo usage

css
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```
button:not(.primary) { opacity: .6; }
```

Powerful for DRY selectors.

Pseudo-elements useful patterns

- Decorative icons without HTML:

css
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```
.btn::after { content: "→"; margin-left: 8px; }
```

Exercise 2

- Make a small nav. Use `:hover`, `:focus`, and `:not()` to style states. Add an `::after` arrow on external links (`a[href^="http"]::after { content: " ↗"; }`).

Chapter 3 — Cascade, Inheritance & Keywords (Deep)

Inheritance

- Certain properties inherit (`color`, `font-family`, `line-height`).
- Others do not (`margin`, `padding`, `width`).
  Use `inherit` to force inheritance:

css
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```
.card * { color: inherit; }
```

Keywords

- `initial`: resets to initial value defined by spec.
- `inherit`: inherit from parent.
- `unset`: acts as `inherit` if property naturally inherits, else `initial`.
- `revert`: revert to previous origin (useful when undoing author/user-agent rules).

Author vs user-agent styles

- E.g., browsers apply default `margin` to `body` and `h1`. Use CSS reset/normalize.

Exercise 3

- Inspect default browser styles for `h1`, `p` using DevTools → note defaults. Apply a tiny reset and compare.

Chapter 4 — Units, Colors & Responsive sizing (Deep)

Units explained

- `px` — device pixels (but modern devices have devicePixelRatio; conceptually stable).
- `%` — relative to parent dimension (width/height context matters).
- `em` — relative to **current** font-size (can compound).
- `rem` — relative to root `<html>` font-size (stable; recommended for UI).
- `vw`, `vh` — viewport units (1vw = 1% of viewport width).
- `vmin`, `vmax` — min/max of vw/vh.
- `ch` — width of `0` character (useful for monospace body).
- `ex` — x-height (rare).

Fluid typography

css
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```
html { font-size: 16px; } /* 1rem = 16px */
h1 { font-size: clamp(1.5rem, 3vw, 3rem); }
```

`clamp(min, preferred, max)` is gold: fluid but bounded.

Colors

- `hex`: `#RRGGBB` or `#RGB` or with alpha `#RRGGBBAA` (some browsers).
- `rgb()` / `rgba()` — use rgba if you need alpha pre-CSS Color 4.
- `hsl()` — easier for hue/saturation/lightness adjustments.
- `lab()` / `lch()` for advanced color math (CSS Color Level 4).

Contrast & accessibility

- Aim for WCAG contrast ≥ 4.5:1 for body text. Tools exist (axe, Lighthouse).

Exercise 4

- Build a small theme with CSS variables for colors and sizing:

css
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```
:root {
  --bg: #fff;
  --text: #111;
  --accent: #06b6d4;
  --space: 1rem;
}
```

Use `var(--accent)` across UI.

Chapter 5 — Box Model & Layout mechanics (Deep)

Box model recap

- Total size = content + padding + border + margin.
- `box-sizing: border-box` recommended globally.

Margin collapsing

- Vertical margins between block elements may collapse — meaning they combine, not add.

- To avoid: use padding, borders, or create a new formatting context (e.g., `overflow: auto` or `display: flow-root`).

Formatting contexts

- Block formatting context (BFC) created by `float`, `position: absolute/fixed`, `display: inline-block`, `display: flow-root`, etc.

- BFC prevents margin collapse and contains floats.

Exercise 5

- Make 3 stacked boxes with large top/bottom margins — observe margin collapsing. Then apply `overflow: auto` to parent to stop collapsing.

Chapter 6 — Display & Visibility (Deep)

Display values

- `block`, `inline`, `inline-block`, `flex`, `grid`, `table`, `list-item`, `none`, `contents`.

- `display: contents` removes the box of the element but preserves children for layout — useful for semantic wrappers but breaks accessibility & CSS targeting (be cautious).

Visibility

- `visibility: hidden` — hides but keeps layout space.

- `display: none` — removes from layout flow (no space).

- `opacity: 0` — visually hidden but still clickable and in flow.

When to use each

- Toggle UI: `display` if completely hiding; `visibility` if you want to reserve space; `opacity` if you animate fade-in (and use `pointer-events: none` while hidden).

Exercise 6

- Create an element that fades out (opacity + transition) and then after transition ends sets `display: none` via JS (or simulate via `:not(.hidden)` pattern).

Chapter 7 — Positioning & Stacking Contexts (Deep)

Positioning summary

- `static` — normal flow, ignore top/right/bottom/left.
- `relative` — stays in flow; offsets move visual but not layout position.
- `absolute` — removed from flow; positioned relative to nearest *positioned* ancestor (non-static).
- `fixed` — relative to viewport.
- `sticky` — acts like `relative` until threshold, then behaves like `fixed` within parent scroll container.

Stacking contexts & z-index

- A stacking context isolates z-index: elements inside that context cannot escape to overlay elements outside unless the stacking context itself has a z-index.
- Creating stacking contexts: `position` + `z-index` (on positioned elements), `opacity < 1`, `transform` (non-none), `will-change`, `filter`, `mix-blend-mode`, `isolation:isolate`, `contain`.
- Common bug: `transform` on parent creates new stacking context, child `z-index` won't overlay outside sibling of parent. Debug: temporarily remove `transform`.

Exercise 7

- Create two overlapping boxes; make one a child of a transformed parent; see how stacking changes. Fix by moving transform or adjusting stacking.

Chapter 8 — Flexbox (Full Deep)

Core idea: 1-D layout (row or column). Good for navs, toolbars, small grids.

Container props

- `display: flex` (or `inline-flex`)
- `flex-direction: row | row-reverse | column | column-reverse`
- `flex-wrap: nowrap | wrap | wrap-reverse`
- `justify-content: flex-start | center | space-between | space-around | space-evenly`
- `align-items: stretch | flex-start | flex-end | center | baseline`
- `align-content` (for multi-line flex containers)

Item props

- `order` (source order reorder)
- `flex: [grow] [shrink] [basis]` shorthand (e.g., `flex: 1 1 0%` or simply `flex:1`)
- `align-self` to override `align-items`

Common recipes

- Centering both axes:

css
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```
.container { display:flex; align-items:center; justify-content:center;
}
```

- Equal-height columns: flex items will stretch by default.

Performance & gotchas

- Avoid heavy nesting of flex containers when grid would solve simpler.
- `min-height` or `min-width` in flex items can cause unexpected overflow — keep `min-width: 0` on flex children to allow shrinking.

Exercise 8

- Build a responsive navbar with logo left, links center, and actions right. On small screens, collapse links into a vertical list.

Chapter 9 — CSS Grid (Full Deep)

Core idea: 2-D layout (rows + columns) — use for full-page layouts and complex components.

Grid properties

- `display: grid`
- `grid-template-columns/rows` — explicit tracks
    - e.g., `grid-template-columns: 200px 1fr 300px;`
    - `repeat(3, 1fr)`
    - `minmax(200px, 1fr)`
- `gap` (row-gap, column-gap)
- `grid-auto-flow: row | column | dense`

- `grid-auto-rows`, `grid-auto-columns` for implicit tracks
- `grid-template-areas` & `grid-area` for named placement

Line-based placement

- `grid-column: 1 / 3;` spans columns 1–2.
- Start/end lines can be negative: `-1` means last line.

Subgrid

- When nesting grids, `subgrid` lets child inherit parent track sizes (powerful; limited browser support historically but improving).

Auto-fit vs auto-fill

css
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```
grid-template-columns: repeat(auto-fit, minmax(250px, 1fr));
```

- `auto-fit`: shrink empty tracks; `auto-fill`: keep empty tracks.

Practical patterns

- Holy grail layout: header, sidebar, content, footer — easy with `grid-template-areas`.
- Masonry-like layout: `grid-auto-flow: dense;` + spanning items but not perfect (use JS for full masonry).

Exercise 9

- Build a dashboard: header, left nav, content grid with cards (grid for layout, flex for card internals).

Chapter 10 — Images, Media & Object Fit (Deep)

Responsive images

- `img { max-width: 100%; height: auto; }` — prevents overflow.
- Use `picture` + `srcset` for art direction and responsive assets.

`object-fit`

- `cover` — image fills container, may crop.
- `contain` — entire image visible, may letterbox.
- `fill` — stretch to container.

`aspect-ratio`

css
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```
.card-image { aspect-ratio: 16 / 9; object-fit: cover; }
```

This prevents layout shifts and preserves intended ratio.

Exercise 10

- Create a responsive gallery using `grid` + `object-fit: cover`. Use `aspect-ratio` so images don't jump.

Chapter 11 — Transforms, Transitions & Animations (Deep)

Transforms (compose them in order)

css
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```
transform: translateX(10px) rotate(15deg) scale(1.05);
```

Order matters: rotate then translate ≠ translate then rotate.

Transitions

css
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```
transition-property: transform, opacity;
transition-duration: 250ms;
transition-timing-function: cubic-bezier(.2,.8,.2,1);
```

Prefer `transform` & `opacity` for GPU-accelerated animations.

Keyframes

css
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```
@keyframes slideUp {
  0% { transform: translateY(20px); opacity: 0; }
  100% { transform: translateY(0); opacity: 1; }
}
.el { animation: slideUp .6s ease forwards; }
```

Animation control

- `animation-iteration-count`
- `animation-direction: alternate` (for back-and-forth)
- `animation-fill-mode: forwards` to preserve end state

Performance

- Layout/paint vs composite: animating `width/height/top/left` triggers layout/paint (expensive). Animating `transform` & `opacity` stays in composite layer — smooth.

Reduce motion

- Respect `prefers-reduced-motion: reduce`:

css
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```
@media (prefers-reduced-motion: reduce) {
  * { animation-duration: 0.01ms !important; transition-duration: 0.01ms !important; }
}
```

Exercise 11

- Build a card that lifts on hover (`transform: translateY(-6px) scale(1.02)`) and uses shadow transition. Add `prefers-reduced-motion` fallback.

Chapter 12 — Filters, Blend Modes & Visual Effects (Deep)

Filters

css
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```
filter: blur(4px) saturate(120%) contrast(110%);
```

Useful for image effects, HUDs, hover states. Note: filters can be costly.

Blend modes

- `mix-blend-mode: multiply | screen | overlay | darken | lighten`
- `background-blend-mode` to blend layered backgrounds.

Clip-path & masks

- `clip-path: circle(50% at 50% 50%)` — create circular crop without extra markup.

- `mask-image` with gradients to fade edges.

Drop shadows

- `box-shadow` great for depth; multiple shadows layered create subtle effects.

Exercise 12

- Create a hero card with glass effect: semi-transparent background + backdrop-filter (blur) and subtle border.

Note: `backdrop-filter` affects what's *behind* the element; requires `background: rgba(...)` and has limited support — provide fallback.

Chapter 13 — Responsive Design & Modern Patterns (Deep)

Viewport meta

html
CopyEdit
```
<meta name="viewport" content="width=device-width, initial-scale=1">
```

Essential for mobile.

Media queries

- Mobile-first: base styles for mobile, then `@media (min-width: 640px) { ... }`.
- Use `em` or `rem` in media queries for accessibility / zoom-friendliness.

Container queries

- Component-level responsiveness:

css

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```
.card { container-type: inline-size; }
@container (min-width: 400px) { .card { grid-template-columns: 1fr
200px; } }
```

Great for modular components.

Fluid grids

- `repeat(auto-fit, minmax(200px, 1fr))` for responsive columns.

Breakpoints

- Don’t slavishly use framework breakpoints; test your design and set breakpoints where layout breaks.

Exercise 13

- Create a component that changes layout via `@container` when its container width crosses a threshold.

Chapter 14 — CSS Variables, Functions & Theming (Deep)

Variables

css
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```
:root {
  --bg: #fff;
  --text: #111;
  --primary: 220 85% 56%; /* for hsl usage with alpha easier */
  --gap: 1rem;
}
```

Use variables in combos:

css
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```
.btn { background-color: hsl(var(--primary)); }
.btn::after { content: var(--caret, "»"); }
```

Scope & overrides

- Variables follow cascade. Override in a selector to scope:

css
CopyEdit

```
.card { --card-bg: #f7f7f7; }
```

`calc()`, `min()`, `max()`, `clamp()`

- Mix units cleanly:

css
CopyEdit

```
width: calc(100% - 2rem);
font-size: clamp(1rem, 2.5vw, 1.25rem);
```

Theming

- Toggle root variables to implement dark/light modes:

css
CopyEdit

```
:root[data-theme="dark"] { --bg: #101010; --text: #e6e6e6; }
```

Exercise 14

- Implement a theme toggle (JS toggles `data-theme` on `<html>`) and use variables for colors, spacing, and radii.

Chapter 15 — Accessibility & UX (Deep)

Focus management

- Use semantic elements (`button`, `a`, `nav`, `main`).
- Style keyboard focus: `:focus-visible { outline: 3px solid var(--accent); }`
- Avoid removing focus outlines unless replaced with well-contrasting style.

Reduced motion

- Respect `prefers-reduced-motion`.

Color contrast

- Aim 4.5:1 for text; 3:1 for large text / UI components.

Readable typography

- Base font 16px (1rem), line-height 1.4–1.6, max line length ~60–75 ch.

Exercise 15

- Make a form with accessible labels (use `label for`), visible focus states, and error messages.

Chapter 16 — CSS Architecture & Maintainability (Deep)

Naming

- BEM: `.block__elem--modifier` keeps components predictable.
- Utility-first: tiny classes (`.p-4`, `.text-center`) — fast but can clutter HTML.

File structure

- `base/` (resets, typography), `components/` (buttons, cards), `layout/` (grid, nav), `pages/` (page-specific), `themes/` (variables).

Performance

- Critical CSS: inline above-the-fold CSS for fast first paint.
- Code splitting: load heavy CSS async for non-critical parts.
- Minify & compress (gzip/brotli).

Tooling

- Use PostCSS, Autoprefixer, CSS linters (stylelint).
- Use CSS-in-JS sparingly — weigh tradeoffs team-wise.

Exercise 16

- Sketch a file/folder structure for a medium project and declare where variables live, where components live, and what naming convention you'll use.

Chapter 17 — Browser Quirks & Debugging (Deep)

Common gotchas

- `min-width` issues with flex items → set `min-width: 0` on flex children.
- `overflow: hidden` sometimes clips shadows.
- `position: sticky` fails if ancestor has `overflow` other than `visible`.

DevTools tips

- Layout tab (inspect grid/flex overlays).

- Computed tab to see final property values & specificity.
- Performance tab for paint/layout/JS profiling.

Cross-browser

- Check modern CSS support (container queries, subgrid) and provide fallbacks or progressive enhancement.

Exercise 17

- Use DevTools to show the grid overlay and change `gap` live. Identify a stacking context issue and fix it by adjusting transform/z-index.

Chapter 18 — Advanced Topics & New Stuff (Deep)

`:has()` selector

- Parent selector (dynamic): `article:has(img)` — powerful but check support.

CSS Layers

- `@layer` for ordering in large projects and preventing specificity fights.

Container queries & subgrid — re-emphasis: modular components, final frontier.

CSS Houdini (preview)

- Low-level APIs to extend CSS capabilities (paint API, Typed OM) — advanced, still niche.

Exercise 18

- Use `@layer` to define `reset`, `base`, `components` layers. Confirm order.

Final Mega Project — Put it All Together

Build a small single-page app (SPA-like) in one file:

- Header with sticky nav (flex)
- Hero with background image (cover), gradient overlay, fluid typography
- Features section in grid (`auto-fit` + `minmax()`)
- Card components with hover animation & accessible focus
- Responsive footer
- Theme toggle (CSS variables)
- Container-query-powered card that rearranges internally when packed narrow
- Respect `prefers-reduced-motion`

I can generate this single-file starter if you want — ready to paste into CodePen.

Quick Reference: Performance & Best Practices

- Animate `transform` & `opacity` only.
- Use `will-change` sparingly (hinting is costly).
- Avoid deep selector chains (keep specificity low).
- Use `border-box`.
- Optimize images (responsive `srcset`, compressed formats like WebP/AVIF).
- Use CSS variables for maintainability & theming.
- Respect accessibility (contrast, focus, reduced motion).